

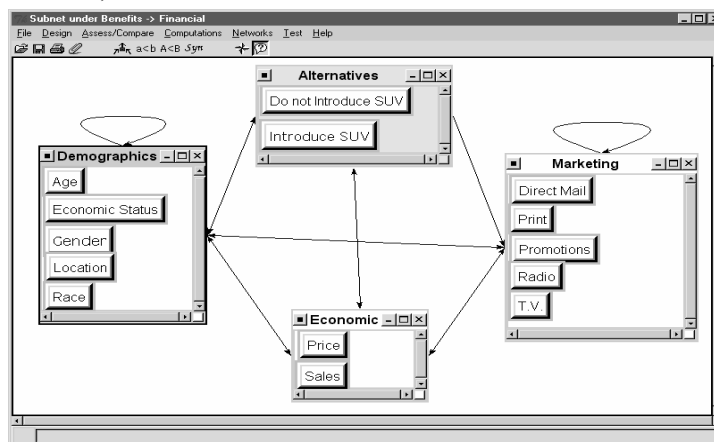
The Essentials of the Analytic Network Process with Seven Examples (4)

- Decision Making with Dependence and Feedback

• Thomas L. Saaty

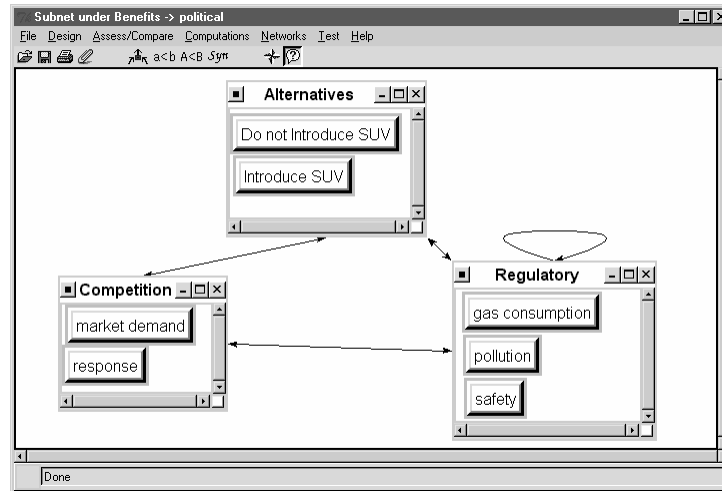
Two Representative Decision Networks (decision networks are bottom level subnetworks)

Benefits, Financial



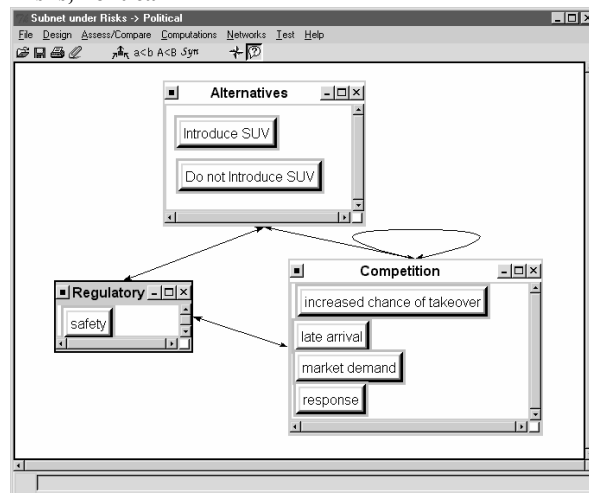
Results in this subnetwork:
Do not introduce SUV .42
Introduce SUV .58

Benefits, Political



Results in this subnetwork:
Do not introduce SUV .30
Introduce SUV .70

Risks, Political



Results in this subnetwork (in terms of MOST risky):
Do not introduce SUV .68
Introduce SUV .32

Results of Porsche SUV Model Shown using Three Methods of Synthesizing the Benefits, Costs and Risks

Alternatives	O/(CR)		oO+c(1-C)+r(1-R) b,c,r are OCR wts		oO-cC+rR b,c,r are OCR wts		Unitized
	(Using Ideals)	Normalized	(Using Ideal.)	Normalized	(Using Ideals)	(Divide by 0.68)	
Do not introduce SUV	0.09	0.08	0.23	0.19	-1	-1.471	
Introduce SUV	1	0.92	1	0.81	0.68	1	

The results seem overwhelming that Porsche should introduce an SUV and in fact they plan to introduce the first non-sports car in their 53-year history next year, the Cayenne: a four-door, four-seat vehicle with a tailgate and four-wheel drive.

ANP Applications (cont.)

Special Projects

- Forecasting the Date of a Turnaround in the U.S. Economy
- Estimating the Market Shares of Fast Food Restaurants (McDonalds, Wendy's, Burger King)
- Decision by the U.S. Congress on China's Trade Status
- Where to Dispose of Nuclear Waste
- Whether or not to Commit U.S. to the Deployment of a Nationale Missile Defense System

The Most Hopeful Outcome in the Middle East Conflict



The Conflict in the Middle East

Our analysis is carried out in three steps:

1. Developing control criteria, and subcriteria for each of the BOCR, performing pairwise comparisons, and then prioritizing them.
2. Developing decision networks and synthesizing the priorities for each of the control criteria and then also for each of the BOCR and then all four BOCR merits to obtain the final outcome.

3. Rating the benefits, opportunities, costs, and risks (BOCR) merits of resolving the conflict to Middle East Peace, International Politics, and Human Well-being.

ALTERNATIVES

1. Interminable Confrontation: This is the ongoing confrontation and conflict as we know it today through military and other actions of bloodshed.
2. Enforcement & Supervision of Settlement: This is to supervise negotiation between Israel and the Palestinians by international organizations, and enforce implementation of the agreements.

3. **Strict & Legal Settlement without Enforcement:** This is to force both Israel and the Palestinians to observe their mutual agreement by legal means, by the UN, and by world public opinion.
4. **Good Faith Settlement as in the Rabin era:** This is to maintain or establish a peace treaty designed to avoid military confrontations through carrying it out in a friendly way only between Israel and the Palestinians.

5. **Economic Assistance to the Palestinians:** This is to help the Palestinians with economic development, education, and more generally planning a promising future.

Strategic Criteria

Three strategic criteria along with subcriteria are developed to evaluate the priorities of the BOCR merits. They are:

- Middle East Peace,
- International Politics,
- Human Well-Being.

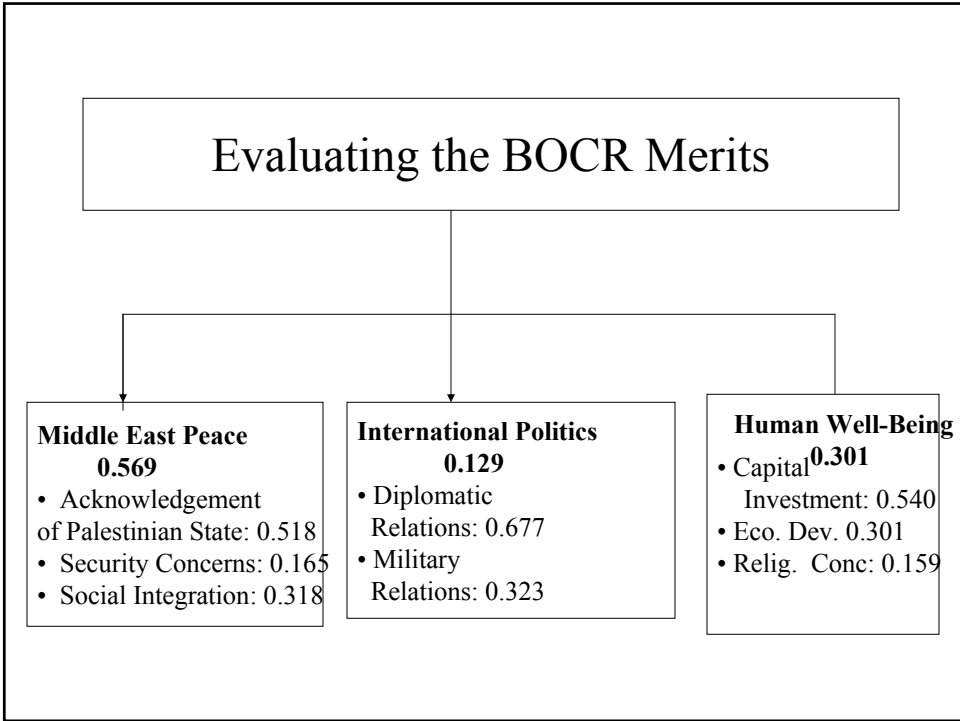
Strategic criteria:

. *Middle East Peace.* The Israeli-Palestinian conflict has largely affected the interests of several other countries including Arab, the U.S., and other countries. Resolution of the conflict is expected to eventually lead to peace in the Middle East. Acknowledgement of a Palestinian State can help permanent peace with social integration and graduate consensus on the issue. Also, security concern means that increasing one country's security can inevitably decrease the security of the other.

International Politics. The Israeli-Palestinian conflict has been related to the international political sphere by affecting the foreign policy and military outlook of other countries not directly involved in the conflict, such as Russia and Saudi Arabia for diplomatic outlook, and Iraq, Iran, and North Korea for military outlook.



Human Well-being. This is one of the aspirations to which resolving the conflict would contribute in no small measure. The conflict could lead to use of nuclear weapons by terrorists thus inviting retaliation against nations not directly responsible and eventually leading to a global conflagration. Human well-being is divided into capital investment, economic development, and religious concerns. Capital investment is driven by the economic effort to resolve the conflict and the hope that it would ultimately benefit all the people. Economic development also leads to rebuilding economies that have been stagnant due to the long lasting conflict. Religious concerns refer to tensions between East and West, and more significantly between Islam and Christianity that have taken place since the event of September 11, 2001.



**Priority Ratings form the Merits:
Benefits, Opportunities, Costs and Risks**

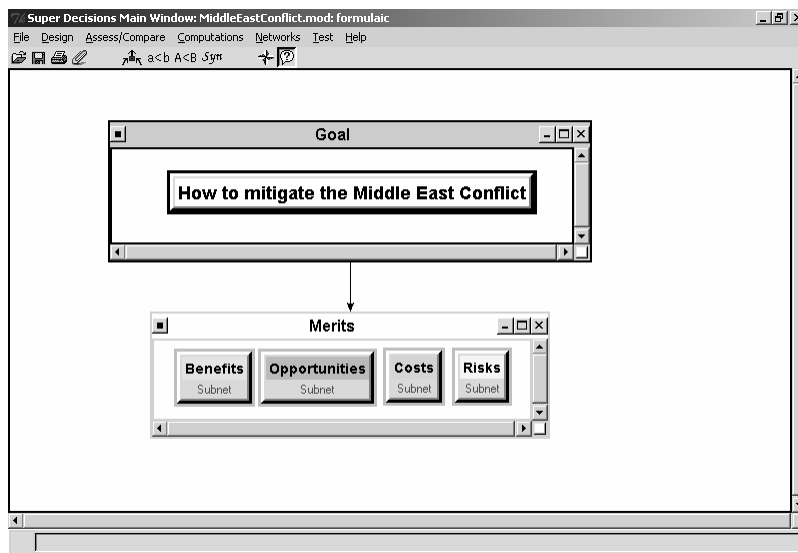
Very High (0.42), High (0.26), Medium (0.16), Low (0.1), Very Low (0.06)

		Benefits	Opportunities	Costs	Risks
Middle East Peace	Acknowledgement	Very High	High	Very High	High
	Security Concerns	Low	Low	High	High
	Social Integration	High	Medium	High	Medium
Int. Politics	Diplomatic Relation	High	Low	Very High	High
	Military Relations	Medium	Very Low	Medium	Medium
	Capital Investment	High	Medium	Very High	High
Human Well-Being	Economic Develop	High	Medium	High	Medium
	Religious Concerns	Medium	Low	Medium	Medium
Priorities		0.278	0.169	0.328	0.226

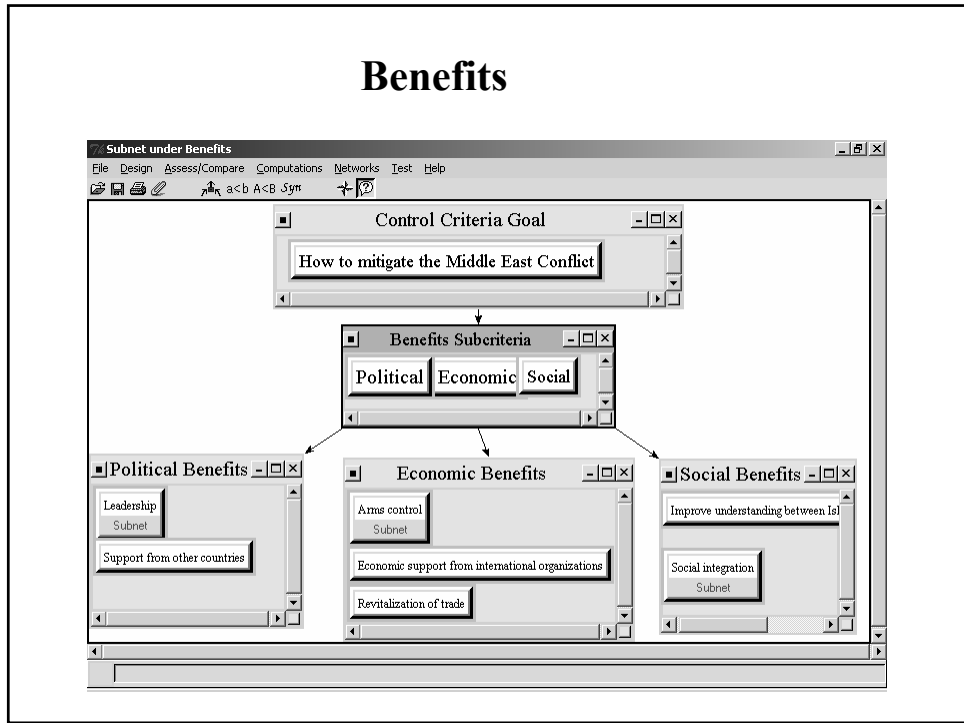
The parties are :

- the U.S. and Israel,
- Palestinian and Arab countries (both friendly and hostile),
- U.S. allies (European and other) including the U.N.

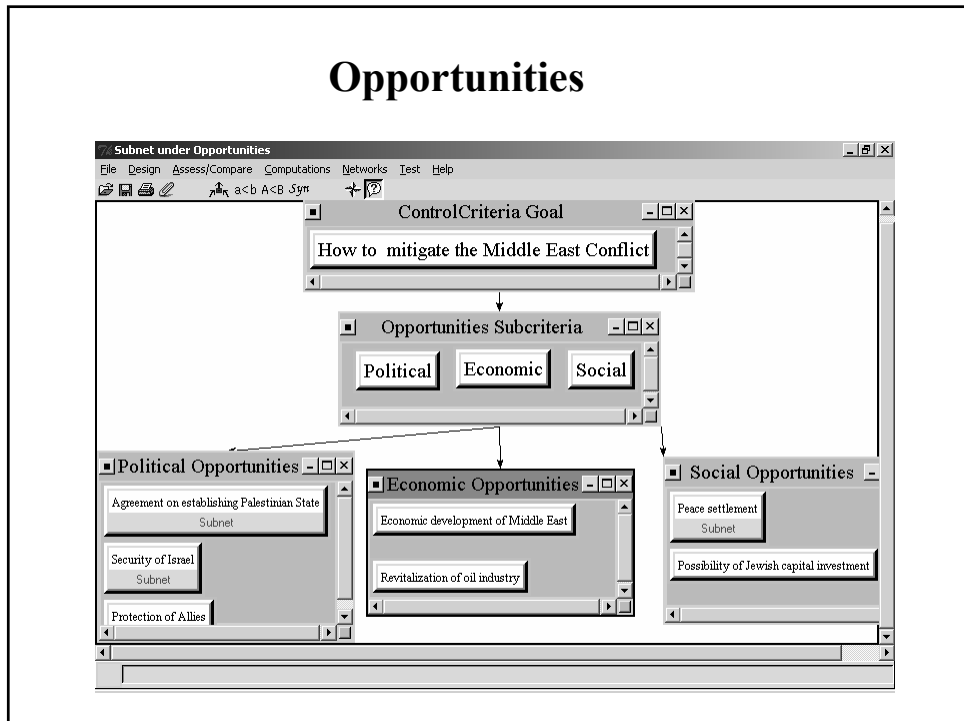
To save time and effort, we did not consider China, Russia, or India as sufficiently influential to include in our prioritization process.



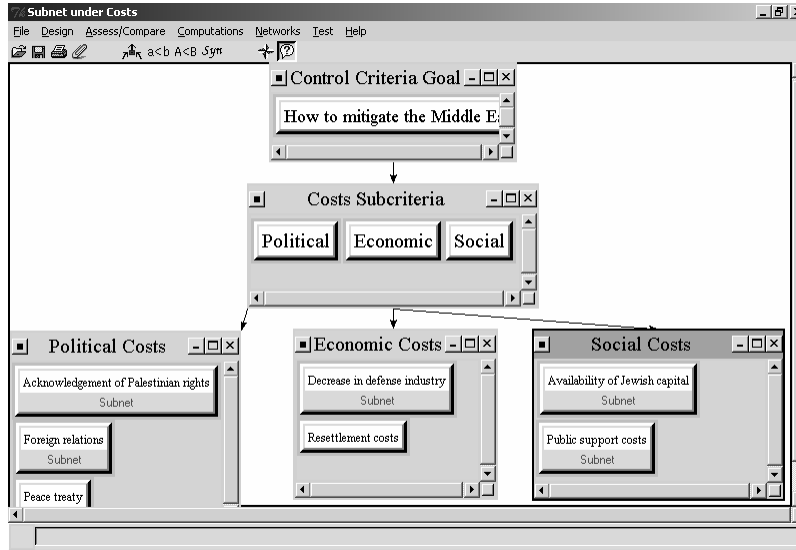
Benefits



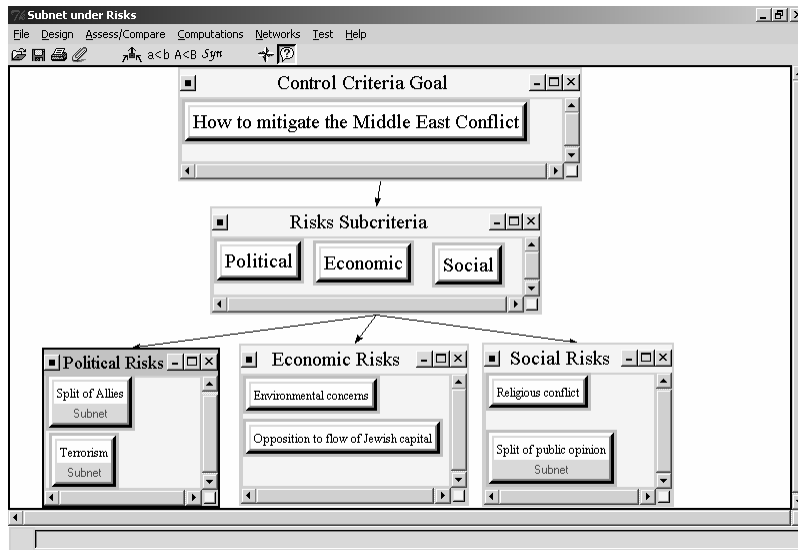
Opportunities



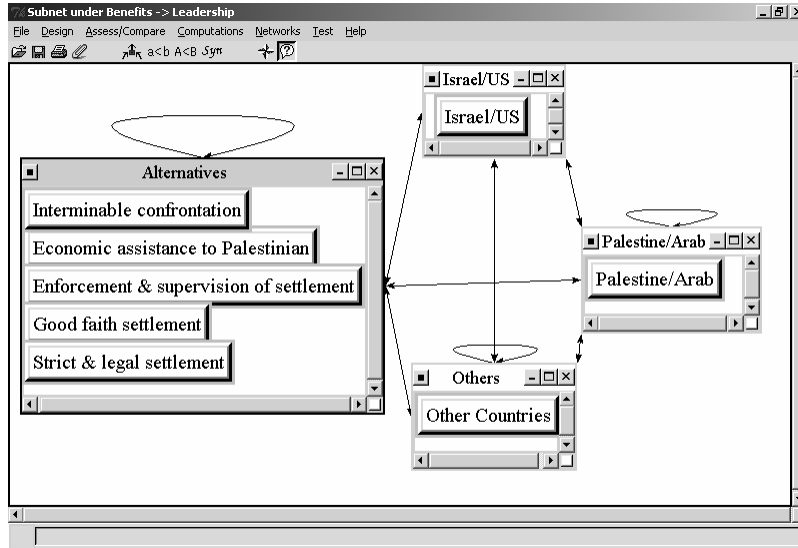
Costs



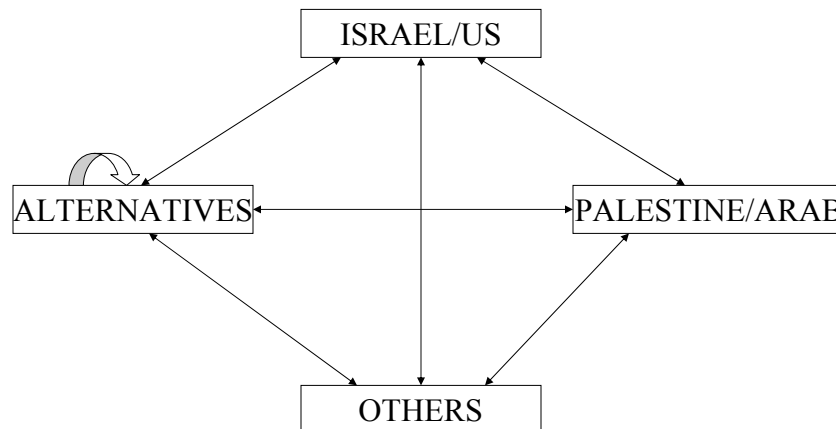
Risks



Sample Decision Network for Leadership Benefits

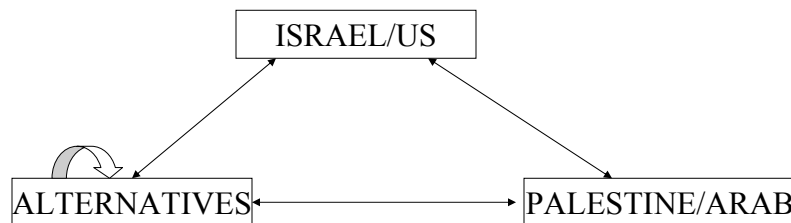


LEADERSHIP NETWORK



Each control criteria has a network of actors and their influences.

PUBLIC SUPPORT COST NETWORK



These decision networks show the relationship of each of the actors with respect to alternatives.

Pairwise Comparison

The judgments are entered using the fundamental scale of the ANP: a criterion compared with itself is always assigned the value 1 so the main diagonal entries of the pairwise comparison matrix are all 1. The numbers 3, 5, 7, and 9 correspond to the verbal judgments “moderately more important”, “strongly more important”, “very strongly more important”, and “extremely more important” (with 2, 4, 6, and 8 for compromise between the previous values). Reciprocal values are automatically entered in the transpose position.

Political Costs Criteria's Pairwise Comparison Matrix

	Acknowledgement of Palestinian Rights	Foreign Relations	Peace Treaty	Normalized Priority
Acknowledgement of Palestinian Rights	1	2	4	0.557
Foreign Relations	1/2	1	2	0.294
Peace Treaty	1/4	1/2	1	0.149

CRITERIA AND THEIR PRIORITIES

Merits	Criteria	Subcriteria	Local Priorities	Global Priorities	Normalized Priorities	
Benefits 0.278	Economic 0.444	Arms Control	0.651	0.080	0.418	
		Economic Support from Int'l Org	0.137	0.017	-	
		Revitalization of Trade	0.212	0.026	-	
	Political 0.215	0.215	Leadership	0.716	0.043	0.222
			Support from Other Countries	0.284	0.017	-
	Social 0.342	0.342	Improve Understanding between	0.273	0.026	-
Social Integration			0.727	0.069	0.360	
Opportunities 0.169	Economic 0.197	Economic Development of Middk	0.649	0.022	-	
		Revitalization of Oil Industry	0.351	0.012	-	
	Political 0.500	0.500	Agreement on Establishing Palesti	0.368	0.031	0.288
			Protection of Allies	0.098	0.008	-
	Social 0.302	0.302	Security of Israel	0.534	0.045	0.417
			Peace Settlement	0.625	0.032	0.295
		Possibility of Jewish Capital Inves	0.375	0.019	-	
Costs 0.328	Economic 0.170	Decrease in Defense Industry	0.618	0.034	0.122	
		Resettlement Costs	0.382	0.021	-	
	Political 0.512	0.512	Acknowledgement of Palestinian	0.557	0.094	0.332
			Foreign Relations	0.294	0.049	0.175
			Peace Treaty	0.149	0.025	-
	Social 0.318	0.318	Availability of Jewish Capital	0.319	0.033	0.118
Public Support Costs			0.681	0.071	0.252	
Risks 0.226	Economic 0.168	Environmental Concerns	0.314	0.012	-	
		Opposition to flow of Jewish Cap	0.686	0.026	-	
	Political 0.506	0.506	Split of Allies	0.371	0.042	0.256
			Terrorism	0.629	0.072	0.435
	Social 0.326	0.326	Religious Conflict	0.306	0.023	-
Split of Public Opinion			0.694	0.051	0.309	

- Among these 27 criteria, the criteria with the highlighted priorities are used to do the analysis.
- The sum of the priorities of these 14 criteria accounts for 74.6% of the total. These criteria's priorities are above 0.030.
- We then renormalize 14 control criteria's priorities within their respective merits.

Benefits' Overall Results

Alternatives	Arms Control (0.418)	Leadership (0.222)	Social Integration (0.360)	Final Outcome
Interminable Confrontation	0.235	0.251	0.212	0.083
Economic Assistance to Palestinian	1.000	1.000	1.000	0.362
Enforcement & Supervision of Settlement	0.717	0.752	0.707	0.258
Good Faith Settlement	0.365	0.396	0.315	0.124
Strict & Legal Settlement	0.498	0.527	0.455	0.173

Overall Results B+O+1/C+1/R

Alternatives	Benefits (0.278)	Opport. (0.169)	Costs	1/Costs	Risks	1/Risks	Final Outcome
			(0.328)	(Norm.)	(0.226)	(Norm.)	
Interminable Conflict	0.083	0.082	0.347	0.092	0.275	0.136	0.098
Economic Assistance to the Palestinians	0.362	0.402	0.088	0.359	0.135	0.278	0.348
Enforcement & Supervision of Ceasefire	0.258	0.230	0.125	0.254	0.161	0.232	0.247
Good Faith Settlement	0.124	0.135	0.254	0.125	0.237	0.158	0.134
Strict & Legal Settlement	0.173	0.151	0.186	0.170	0.192	0.195	0.174

CONCLUSION



- The final outcome suggests that the best policy to mitigate the Middle East Conflict is to provide the Palestinians with economic assistance. As of now, this policy has never been considered to be essential in resolving the conflict by any of the actors.

•Traditional negotiations have not moved to the conflict closer to resolution because of lack of a strong recognition of the need to give the Palestinians compensation for at least lots of their properties and perhaps make sure that matters have been evenly balanced as far as they feel their rights are concerned.

Furthermore, this kind of resolution does not focus as much on land, territory, and military action as much as it does on humane values and long term future relations.

For related books:

www.superdecisions.com

For related researches:

Thomas L.Saaty

saaty@katz.pitt.edu

SENSITIVITY ANALYSIS

A) BENEFITS AND OPPORTUNITIES

Benefits $0.278 \Rightarrow 0.5$

the economic assistance policy is still preserved as the best policy as among the five alternatives.

Enforcement & supervision of settlement outcome keeps becoming the second best policy as the benefits priority increases.

Opportunities $0.169 \Rightarrow 0.5$

the economic assistance policy is preserved as the best policy as well. Also, enforcement & supervision of settlement still turns out to be the second best policy and interminable confrontation is expected to be the least recommendable policy.

No matter how much we increase or decrease the priorities of benefits and opportunities, the overall rank of the final outcome is preserved although these experiments change the magnitudes of the superiority of the best alternative.

SENSITIVITY ANALYSIS
B) COSTS AND RISKS

Costs $0.328 \Rightarrow 0.5$
the economic assistance policy
still turns out to be the best policy
to deal with.

Risks $0.226 \Rightarrow 0.5$
the economic assistance policy is
still preserved as the best policy

Opportunities $0.169 \Rightarrow 0.5$

the economic assistance policy is
preserved as the best policy as well.
Also, enforcement & supervision of
settlement still turns out to be the
second best policy and interminable
confrontation is expected to be the
least recommendable policy.

No matter how much we increase or decrease the priorities of benefits and opportunities, the overall rank of the final outcome is preserved although these experiments change the magnitudes of the superiority of the best alternative.

ANP and Bayes Theory

- The counterpart of an ANP model in statistical decision analysis is the influence diagram.
- Bayes theorem is the computational basis of influence diagrams.
- Influence diagrams are directed acyclic graphs (no feedback allowed).
- There are situations in which influence diagrams do not capture all the interactions among the elements (e.g., medical diagnosis where symptoms are not independent).
- ANP allows feedback and under very specific assumptions (e.g., No feedback as in a hierarchy) yields results obtained using influence diagrams.
- Chapter 6 of the ANP book shows the relationship and extensions of ANP and Bayes theory in a medical diagnosis setting.

Bayes Theorem (which relies on conditional probabilities) can be represented using reciprocal matrices. Let $A_i, i=1, \dots, n$ be a set of events and let $B_j, j=1, \dots, m$ be a set of outcomes. Bayes theorem gives $P[A_i|B_j]$ as a function of $P[B_j|A_i]$ and $P[A_i]$,

$$P[A_i | B_j] = \frac{P[B_j | A_i]P[A_i]}{P[B_j]} \cdot \text{In matrix form we have:}$$

$$\begin{bmatrix} 1 & \frac{P(A_1)}{P(A_2)} & \dots & \frac{P(A_1)}{P(A_n)} \\ \frac{P(A_2)}{P(A_1)} & 1 & \dots & \frac{P(A_2)}{P(A_n)} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{P(A_n)}{P(A_1)} & \frac{P(A_n)}{P(A_2)} & \dots & 1 \end{bmatrix} \circ \begin{bmatrix} 1 & \frac{P(B_j|A_1)}{P(B_j|A_2)} & \dots & \frac{P(B_j|A_1)}{P(B_j|A_n)} \\ \frac{P(B_j|A_2)}{P(B_j|A_1)} & 1 & \dots & \frac{P(B_j|A_2)}{P(B_j|A_n)} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{P(B_j|A_n)}{P(B_j|A_1)} & \frac{P(B_j|A_n)}{P(B_j|A_2)} & \dots & 1 \end{bmatrix} = \begin{bmatrix} 1 & \frac{P(B_j|A_1)P(A_1)}{P(B_j|A_2)P(A_2)} & \dots & \frac{P(B_j|A_1)P(A_1)}{P(B_j|A_n)P(A_n)} \\ \frac{P(B_j|A_2)P(A_2)}{P(B_j|A_1)P(A_1)} & 1 & \dots & \frac{P(B_j|A_2)P(A_2)}{P(B_j|A_n)P(A_n)} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{P(B_j|A_n)P(A_n)}{P(B_j|A_1)P(A_1)} & \frac{P(B_j|A_n)P(A_n)}{P(B_j|A_2)P(A_2)} & \dots & 1 \end{bmatrix}$$

The principal right eigenvector of this matrix gives the posterior probabilities of the A_i 's for a given B_j which is what Bayes theorem yields.

Question/Goal:

What should the U.S. foreign policy be with regard to Iraq?

Background of the Problem

- *What has brought us to this question?*
 - For 10 years, Iraq has been under UN sanctions for refusal to comply with UN resolutions mandating WMD inspections
 - The Bush Administration's rhetoric has emphasized the idea of U.S. hegemony, providing a foundation for unilateral, pre-emptive action
 - Citing a sincere concern for Iraq's possession/use of WMD, the U.S., backed by its "War on Terrorism", intends to pursue an agenda of aggression against Iraq

The Four Alternatives

- (1) The U.S. should make a unilateral, pre-emptive attack against Iraq
- (2) The U.S. should attack Iraq only with Allied support and/or help
- (3) The U.S. should exhaust diplomatic options by working with UN weapons inspectors to ensure inspections
- (4) Sanctions against Iraq should be removed

Possible Outcomes

Option 1: Pre-emptive, Unilateral Action

- ***Pro:*** A unilateral, pre-emptive attack may do the most to “disarm” Iraq of potential WMD, by seeking and destroying any weapons-making programs or facilities by air or ground force. Additionally, it would serve well the U.S. goal of regime change.
- ***Con:*** A unilateral, pre-emptive attack might alienate the United States from her allies (and future allied support), might threaten the legitimacy and/or future viability of the U.N., may provoke Iraq into using any current WMD as retaliation and, further, might cause a potential increase both in terrorism and/or negative Arab sentiment towards the United States. Additionally, a unilateral strike would place all cost concerns and future Iraqi nation-building upon the U.S.

Possible Outcomes

Option 2 : Attacking only with Allied Support

- ***Pro:*** Attacking only with Allied help and/or support would be a slightly more cautious approach that would still target potential Iraqi WMD threats without alienating American allies or threatening the viability of International Governmental Organizations (IGOs, such as the U.N.) Moreover, it would share the burdens of monetary cost and future peacekeeping/nation-building.
- ***Con:*** Attacking Iraq, even with allied help, would still result in Iraqi retaliation that might result in use of biological or chemical WMD. Additionally, this action might serve to further polarize the Arab and Western worlds.

Possible Outcomes

Option 3: Working with the U.N. to exhaust Diplomatic Options

- ***Pro:*** Exhausting diplomatic options by working with U.N. weapons inspectors would not only uphold the future viability of the UN (and respect for the UN Security Council), but might also serve the intended purpose of determining if/where Iraq has WMD or means to proliferate WMD. This option serves to respect sovereignty, limit cost, and champion diplomacy.
- ***Con:*** Having a decade-long history of non-cooperation with U.N. weapons inspectors, allowing Iraq to continue to draw out the situation may simply give them more time to create WMD, while also mocking the usefulness and viability of the United Nations.

Possible Outcomes

Option 4: Remove Sanctions

- ***Pro:*** Removing sanctions might result in an improved quality of life for the Iraqi people, since many believe that the U.N. sanctions have little to no effect on Saddam Hussein and, instead, merely serve to hurt the Iraqi people and give credence to Hussein's villianization of the United States.
- ***Con:*** Removing sanctions might serve to remove a great deal of credibility from the U.N. as an organization, to threaten future sanction enforcement attempts, and to reduce the viability of future UN operations. Further, removing sanctions might relinquish any leverage that the UN has on Hussein's power and capacity to proliferate and use WMD, giving him a dictatorial carte blanche.

Consideration of Strategic Criteria

- ***Economic :***
 1. Monetary Cost of War
 2. Change in Oil Prices
 3. Focus Shift Away from U.S.Economy

- ***Social :***
 1. Public Opinion
 2. Iraqi Civilian Life

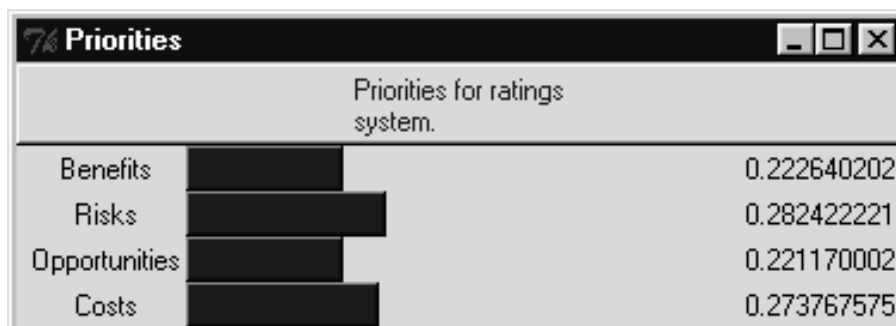
- ***Political :***
 1. Regime Change
 2. Allies Reaction
 3. Arab World Reaction

- ***Military :***
 1. WMD
 2. U.S. Military Casualties
 3. Removal of Dictator

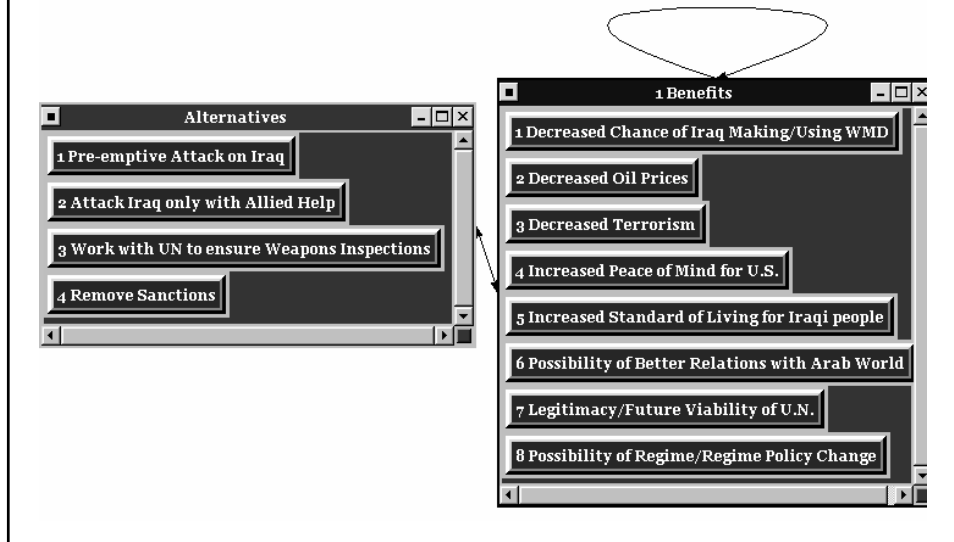
Benefits, Opportunities, Costs & Risks: The BOCR model

- In the BOCR model, the Benefits model indicates which alternative would be most beneficial while the Opportunities model shows which alternative would provide the greatest opportunities.
- Similarly, the Risk model designates which alternative has the highest associated risk, and the Costs model shows which alternative would be most costly.
- It is important to recognize, however, that the model is being created & evaluated in regards to a U.S. policy option. Therefore, Benefits does not necessarily indicate which Alternative would be most beneficial to other countries, including Iraq.

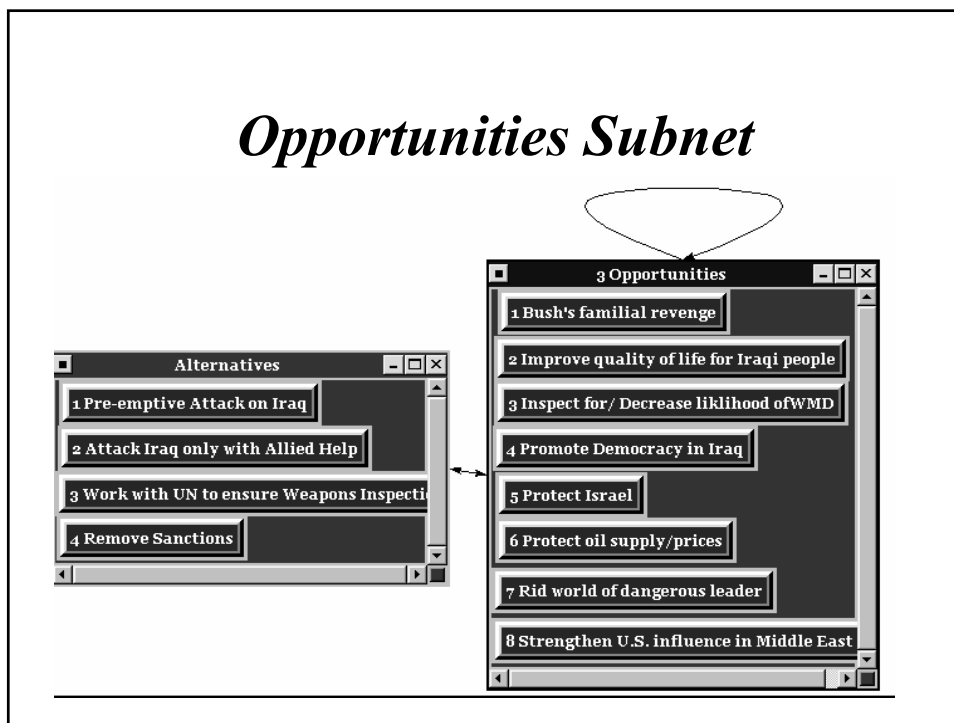
BOCR Ratings



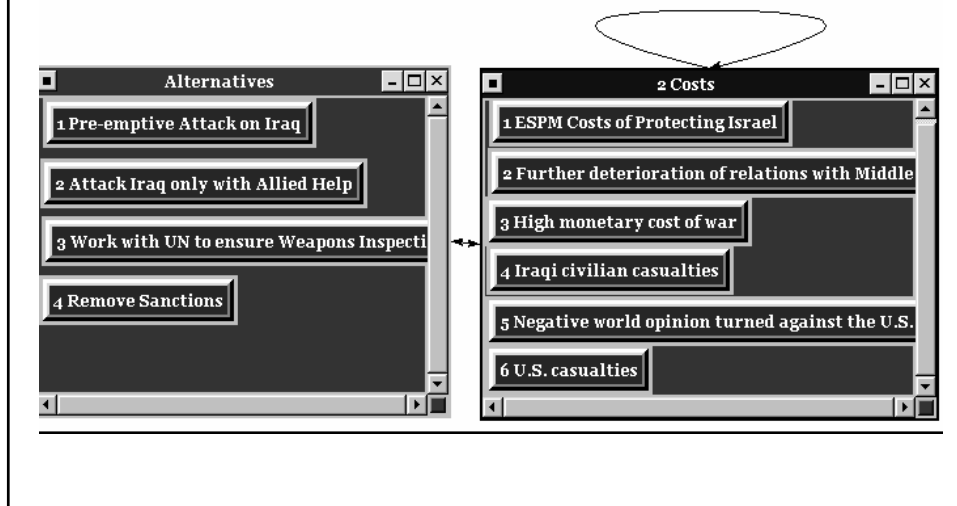
Benefits Subnet



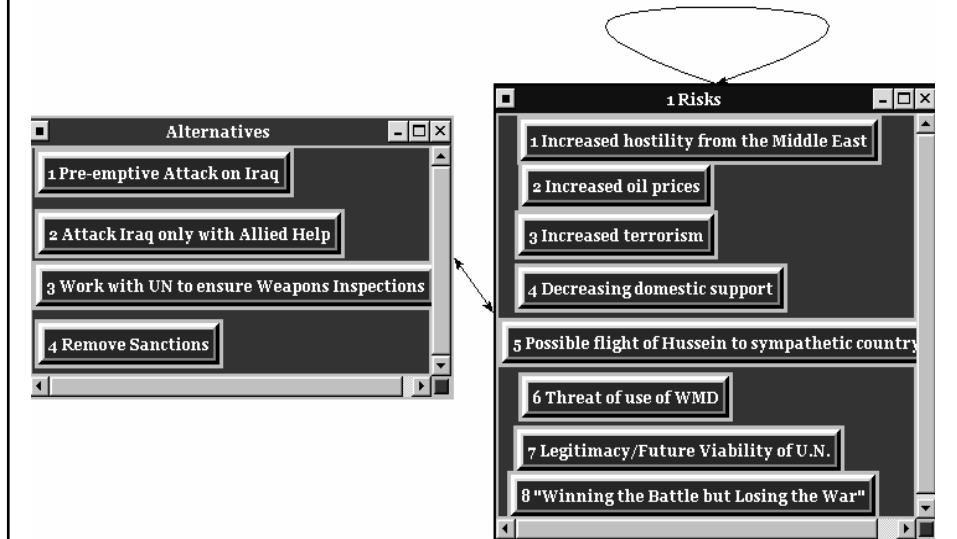
Opportunities Subnet



Costs Subnet



Risks Subnet

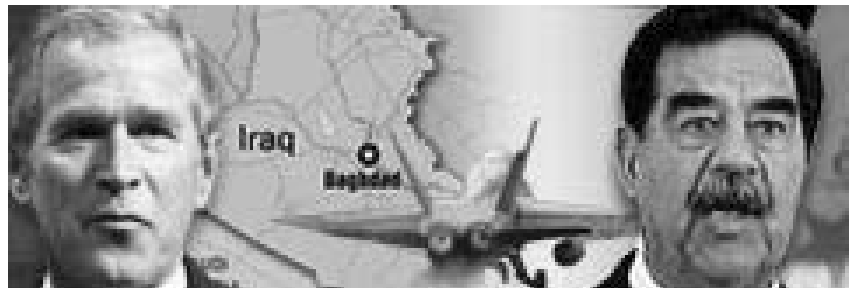


Synthesized Results

These are the results obtained using the Additive Formula with Reciprocals

Name	Graphic	Ideals	Normals	Raw
1 Pre-empti~	██████████	0.432141	0.182712	0.417740
2 Attack Ir~	██████████	0.471680	0.199429	0.455962
3 Work with~	██████████	1.000000	0.422806	0.966677
4 Remove Sa~	██████████	0.461331	0.195054	0.445958

Comments or Questions??



SHORTCUTS WHEN IMPLEMENTING THE ANP PROCESS

- Shorten judgments by doing first row and a couple more, or doing the first row and the diagonal above the diagonal of 1's (not shown in the software).
 - Do subnets directly under the BOCR nodes without using control criteria. To do the judgments well, list the control criteria and keep them in mind to make tradeoffs when you compare with respect to each of the BOCR.
 - Do BO/CR without using strategic criteria to weight them.
 - Otherwise also include strategic criteria to determine the relative importance of each of the BOCR and use the three other formulas to obtain the final result by combining the subnet results under each of the B, O, C and R. In particular the subtraction formula, one of the three, is useful.
 - Make connections carefully and use loops where necessary.
- You now have only four supermatrices to obtain the results from.
- You must compare the clusters to get valid answers. Please do not ignore comparison of clusters, otherwise your work would not be considered a valid approximation to making a good decision.